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Study of Army Aircraft Maintenance-Related Mishap Experience

November 1981

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Study of Army Aircraft Maintenance-Related Mishap Experience

Directorate for Aviation Systems Management

U.S. ARMY SAFETY CENTER

Colonel Edward E. Waldron II
Commander

Contents

PREPARED BY THE U.S. ARMY SAFETY CENTER, FORT RUCKER, ALABAMA.

Study of Army Aircraft Maintenance-Related Mishap Experience 1 October 1976 through 31 December 1980

Introduction

This report provides maintenance-related mishap experience for the period 1 October 1976 through 31 December 1980 and was prepared to aid resource managers, commanders, aviation safety officers, and maintenance personnel in the prevention of aircraft mishaps caused by maintenance errors.

In January 1979, the Army commissioned a special study group to conduct an indepth analysis of Career Management Field 67 (CMF 67) and make recommendations to resolve problems identified. The CMF 67 study, completed in October 1980, contains high-level recommendations addressing organizational and MOS structure, grade/skill level authorizations, personnel retention, maintenance training, etc. The U.S. Army Safety Center participated in the CMF 67 study by providing maintenance-related mishap experience. Although the input for the study covered a slightly different time period, it provided the genesis for development of this report.

Objectives

The overall objectives of this report are to (1) portray and analyze the most current maintenance-related mishap experience, (2) identify specific maintenance errors that result in mishaps, and (3) develop an awareness of the problem throughout the aviation community. Emphasis is placed on providing usable information directed at the unit/intermediate level of maintenance.

Parameters, definitions, and explanations

This report is based on maintenance-related mishaps of the Active Army, Army Guard, and Army Reserve. Mishap data includes all aircraft except the TH-55. Mishap categories are defined in AR 385-40. Rates presented in this report represent maintenance-related mishap rates only and are determined using the formula (mishap experience x 100,000) divided by flying hours. (Flying hours for rotary and fixed wing aircraft are presented at appendix B.) Statistics are subject to minor change as a result of mishap reclassification. The term maintenance-related mishap means there was a maintenance error committed and it contributed to the mishap. For the purpose of this report, some errors were included that were not maintenance per se but were made by maintenance personnel functioning as crewmembers, ground guides, etc. Several cause factors, e.g., pilot error, materiel failure, or maintenance error, could be present in any one mishap. Most mishaps are not investigated by a Safety Center investigation team. The unit having the mishap is responsible for providing the mishap data, including the cause of the mishap. It is suspected that many mishap causes reported by the field as unknown or materiel failure are, in fact, maintenance error. The statistics presented throughout the report, therefore, are considered to be conservative.

Discussion

A total of 16,794 mishaps occurred during the period 1 October 1976 through 31 December 1980 (table 1). Maintenance error was a cause factor in 11 percent (1,790) of all mishaps. A high percentage (28) of aviation ground mishaps were maintenance-related. Many of the maintenance errors listed in appendix D resulted in damage or injury during runup for a maintenance operational check.

Table 2 compares rotary wing versus fixed wing maintenance-related mishap experience. The mishap rate for fixed wing is 32.23 (247 mishaps) versus 28.15 (1,543 mishaps) for rotary wing. The fixed wing rate is slightly higher than the rotary wing rate, but because of the low density of fixed wing aircraft they account for only 14 percent (247 mishaps) of all maintenance-related mishaps. While fixed wing aircraft had only 14 percent of all maintenance-related mishaps, they had 19 percent (21) of the most serious mishaps (A, B, and C) and accounted for 22 percent ($4.6M) of the damage costs. The fixed wing injury/fatality rate was less than the rotary wing rate.

TABLE 1.—Total Aviation Mishap Experience Versus Maintenance-Related Mishap Experience - 1 October 1976-31 December 1980

Mishap Classification	Total Aviation Mishaps	Maintenance-Related Mishaps	Portion of Total Mishaps With Maintenance-Related Causes
A	176	17	10%
B	204	23	11%
C	909	73	8%
D	22	1	5%
E	15,327	1,641	11%
Aviation Ground	89	25	28%
Other	67	10	15%
Total	16,794	1,790	11%
Losses			
Damage Costs	$138.9M	$21.3M	15%
Injury Costs	$20.8M	$2.5M	12%
Total Costs	$159.7M	$23.8M	15%
Fatalities/Missing	135	19	14%
Nonfatal Injuries	303	39	13%

NOTE: A maintenance mishap matrix by type aircraft, mishap classification, and losses is located at appendix A.

TABLE 2.—Fixed Wing and Rotary Wing Maintenance-Related Mishap Experience - 1 October 1976-31 December 1980

Mishap Classification	Rotary Wing	Fixed Wing	Total
A	15	2	17
B	21	2	23
C	56	17	73
D	1	0	1
E	1,416	225	1,641
Aviation Ground	24	1	25
Other	10	0	10
Total	1,543	247	1,790
Losses			
Damage Costs	16.7\overline{M}$	4.6\overline{M}$	21.3\overline{M}$
Injury Costs	$ 2.2$\overline{M}$	$ .3$\overline{M}$	$ 2.5$\overline{M}$
Total Costs	18.9\overline{M}$	4.9\overline{M}$	23.8\overline{M}$
Fatalities/Missing	17	2	19
Nonfatal Injuries	38	1	39

The maintenance-related mishap trend graph (figure 1) shows that while rates have varied from quarter to quarter, there has been an upward trend for fixed and rotary wing. Maintenance-related mishap rates for both fixed and rotary wing have doubled from FY 77 to FY 80. The trend lines for both aircraft increase on the same plane, indicating that factors causing the increase could be common to both type aircraft. Increased emphasis on reporting all mishaps has resulted in more mishaps being reported by the field. This is considered to be the most significant reason for the trend increase.

A maintenance mishap matrix by type aircraft, mishap class, and losses is provided at appendix A. Four models of rotary wing aircraft account for 84 percent of the maintenance-related mishaps. Trend charts on the four aircraft are located at appendix C. While the maintenance-related mishap trends are upward for the four aircraft, the amount of increase varies between aircraft. In comparing rates, it must be recognized that the mishap rate scales vary between aircraft. As expected, the more complex the aircraft the greater the likelihood of a maintenance error. The CH-47 and the AH-1 maintenance-related mishap rates are much higher than the UH-1 or OH-58 rates.

Of the 1,790 maintenance-related mishaps, 1,742 (97 percent) were analyzed on a case-by-case basis. Lists of errors, by type aircraft, are located at appendix D. No attempt has been made in this report to explain why a mechanic made a specific

error that resulted in a mishap. A mechanic who overtorqued a line that eventually broke and caused a mishap may have used improper torquing procedures because his initial aviation MOS training did not provide adequate hands-on training or a properly calibrated torque wrench may not have been available. Managers and supervisors of maintenance personnel should review the errors listed in appendix D in light of their unique operating environment to determine problem areas requiring their attention.

Selected aviation maintenance-related mishap briefs for different aircraft are located at appendix E. The briefs allow the reader to become familiar with and get closer to the problem by providing a detailed, real-world description of the maintenance error and the mishap caused by the error.

A ground mishap (DA Form 285) table is provided at appendix F. All of the mishaps involved maintenance personnel performing maintenance-related tasks or other duty tasks in the maintenance work area. The first 10 categories of ground mishaps account for 75 percent of all mishaps. While materiel improvements, such as insuring serviceable hoists are available, will reduce some of the mishaps, the overwhelming majority of mishaps will not be reduced until there is an attitude change among supervisors and maintenance personnel, and job safety becomes a part of the daily routine.

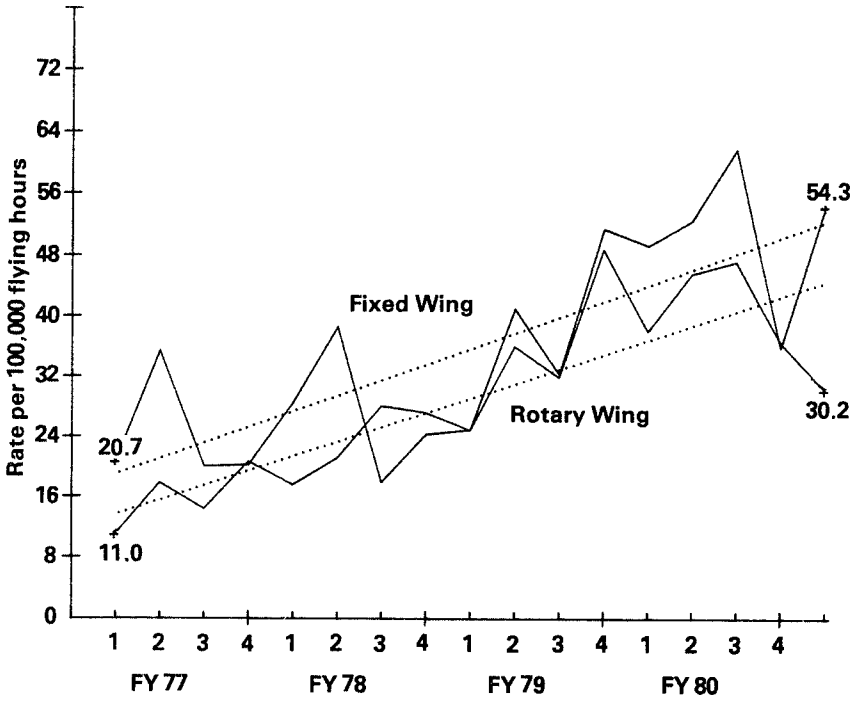


FIGURE 1.—Maintenance-Related Mishaps by Quarter

Conclusions

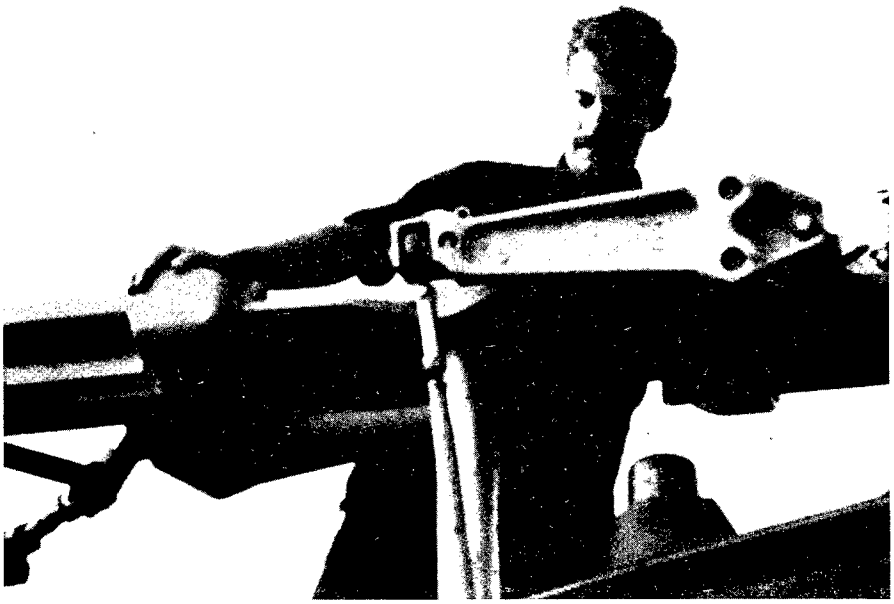
- Maintenance error was a contributing factor in 11 percent of all aviation mishaps. Maintenance-related mishap trends for all of the high density aircraft are upward.

- The majority of the maintenance errors were common to all aircraft. Improper torquing, improper wiring, lack of by-the-book maintenance, etc., caused mishaps in the OH-58 as well as the CH-47. The higher maintenance-related mishap rate for the CH-47, as opposed to the OH-58, is attributed to its increased complexity, producing more opportunities for maintenance errors.

Recommendations

- Long term: The Career Management Field 67 Study, mentioned earlier, concluded that there has been a decline in Army aviation maintenance effectiveness. Reasons cited for the decline in effectiveness include inadequate organizational structure (e.g., lack of qualified supervisors), ineffective MOS structure, inappropriate grade authorizations, unsatisfactory first term reenlistments, a less than effective maintenance training program (e.g., lack of hands-on training), and increased equipment complexity. CMF 67 recommendations addressing these problem areas will, in the long run, reduce the number of maintenance-related mishaps.

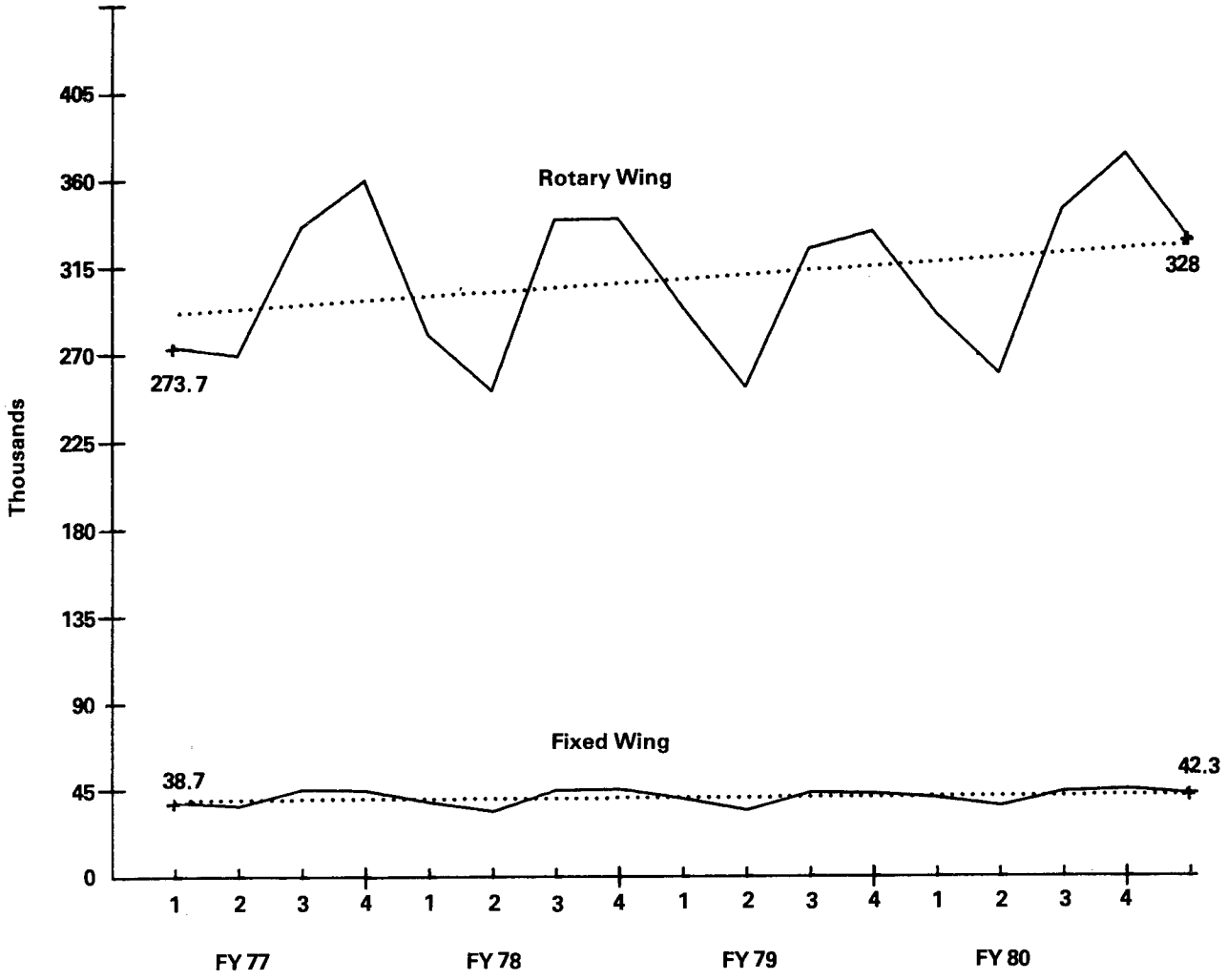
- Short term: Maintenance supervisors should reexamine their maintenance practices in light of the information provided in this report. Maintenance supervisors should develop an awareness among their subordinates as to the maintenance errors that have resulted in aircraft and ground mishaps. All maintenance personnel should reexamine their attitude concerning safety while performing maintenance. Emphasis should be placed on doing what is already prescribed, e.g., by-the-book maintenance, right tool for the job, using protective equipment when required, etc.



Appendix A
Maintenance Mishap Matrix
1 Oct 76-31 Dec 80

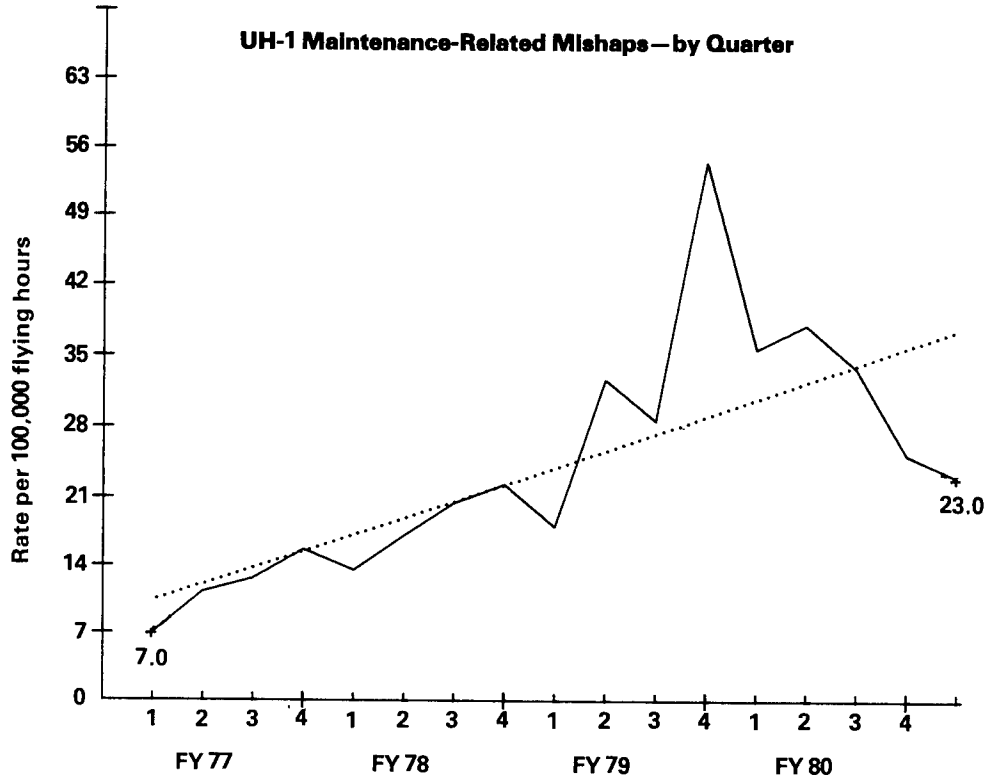
Type Aircraft	Mishap Classification					Avn Gnd	Other	Total Mishaps	Damage Costs	Injury Costs	Total Costs	Fatalities/ Missing	Nonfatal Injuries
	A	B	C	D	E								
Fixed Wing													
C-7					5			5					
C-12			1		26			27					
C-54					1			1					
OV-1	1	2	6		45			54	$1.3M	$.3M	$1.6M	2	
RV-1	1				7			8	$3.3M		$3.3M		1
T-28					2			2					
T-42			1		22			23					
U-3					8			8					
U-8			3		33			36					
U-9					1			1					
U-21			6		75	1		82					
Total	2	2	17		225	1		247	$4.6M	$.3M	$4.9M	2	1
Rotary Wing													
AH-1	3	5	5		221	4	2	240	$2.2M	$.1M	$2.3M	1	5
TH-1					8			8					
CH-47		4	8		147	2	4	165	$9.2M	$.1M	$9.3M	1	5
CH-54		1	1		10			12					
OH-6					10			10					
OH-58	5	4	14	1	274	9		307	$1.0M	$.2M	$1.2M	1	10
UH-1	7	7	27		721	9	4	775	$4.3M	$1.8M	$6.1M	14	18
UH-60			1		25			26					
Total	15	21	56	1	1,416	24	10	1,543	$16.7M	$2.2M	$18.9M	17	38
Grand Total	**17**	**23**	**73**	**1**	**1,641**	**25**	**10**	**1,790**	**$21.3M**	**$2.5M**	**$23.8M**	**19**	**39**

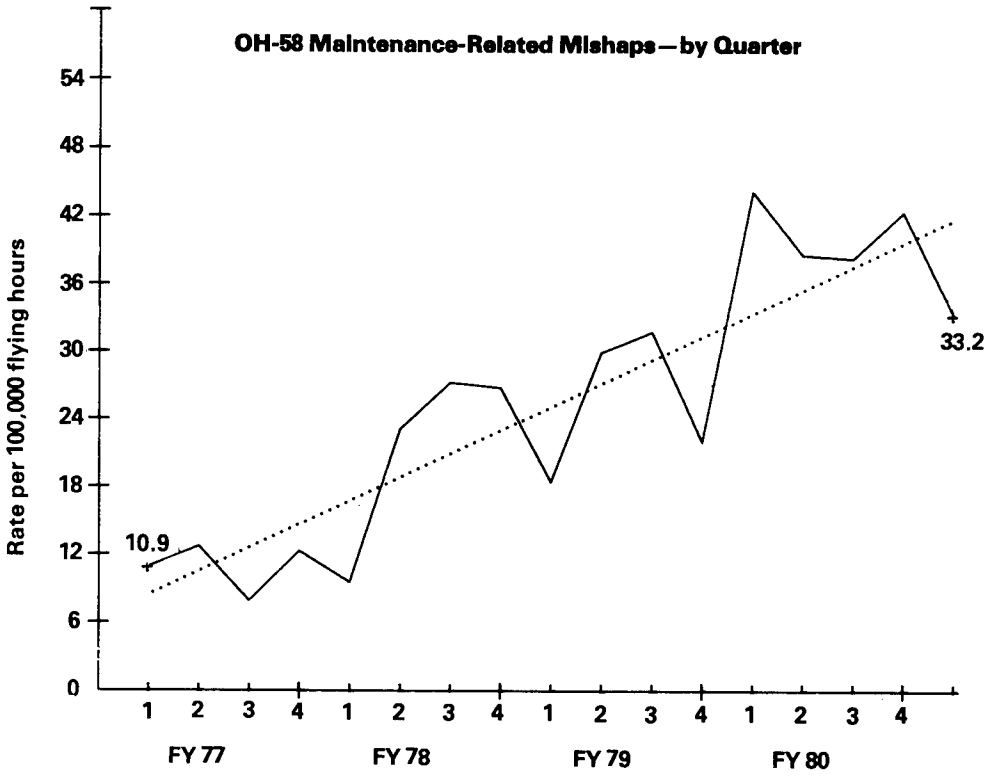
Appendix B
Flying Hours by Quarter

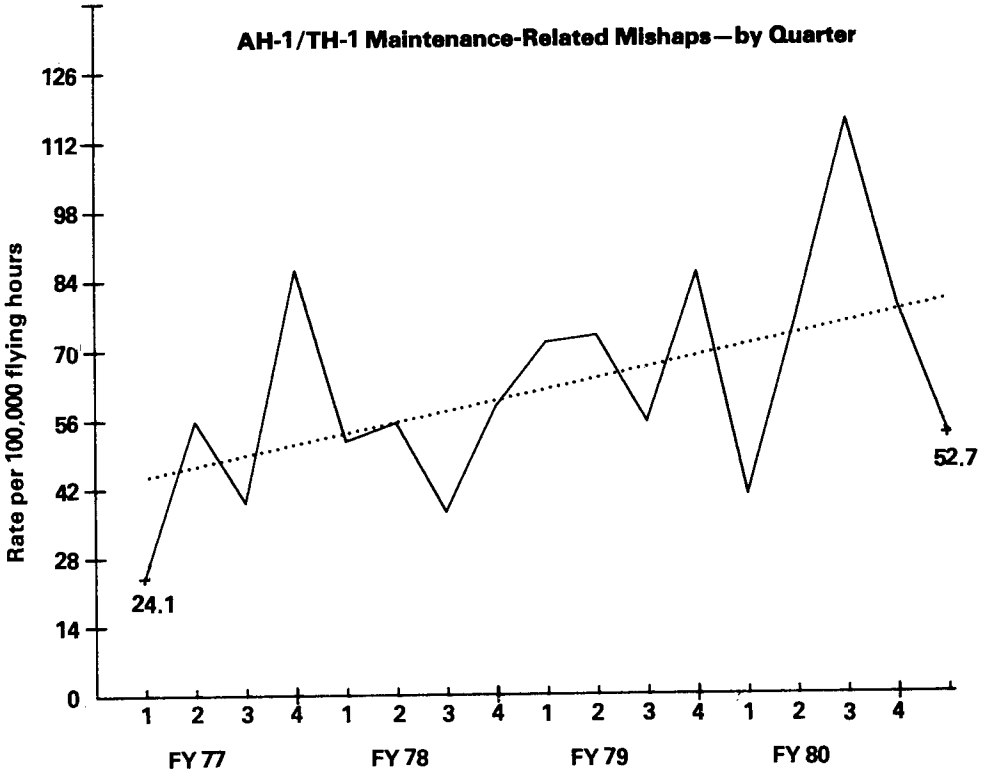


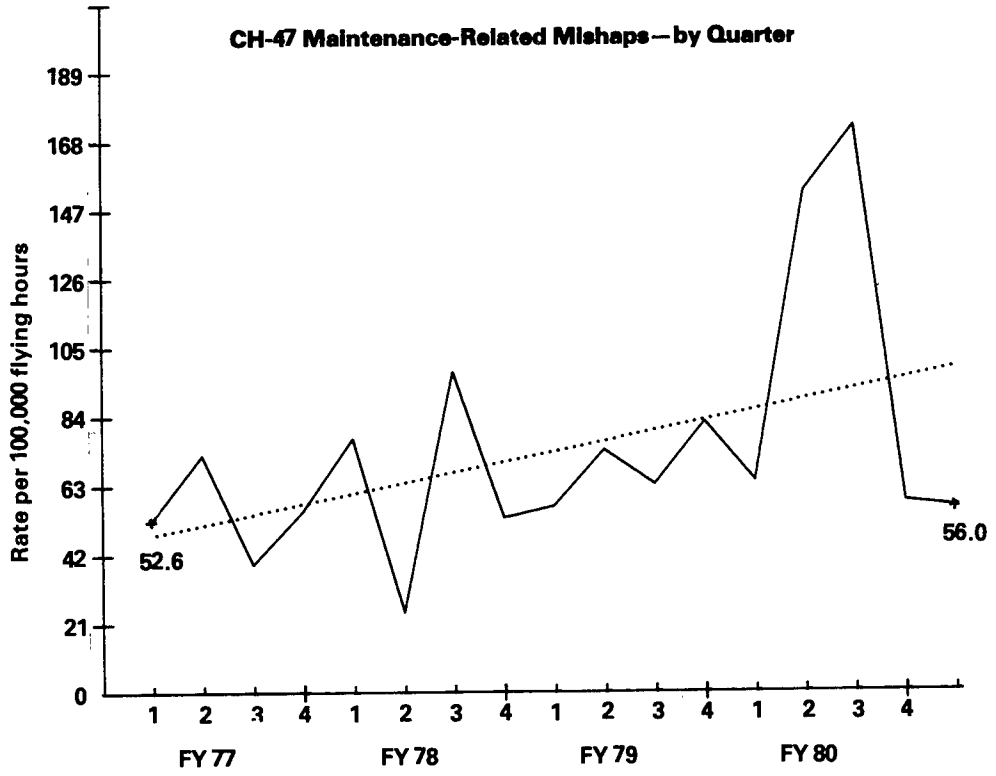
Appendix C
Maintenance-Related Trend Graphs by Type Aircraft

In comparing maintenance error trends, consider that each aircraft has a different mishap rate scale.






AH-1/TH-1 Maintenance-Related Mishaps—by Quarter
Rate per 100,000 flying hours
126
112
98
84
70
56
42
28
14
0
24.1
52.7
1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
FY 77
FY 78
FY 79
FY 80


CH-47 Maintenance-Related Mishaps—by Quarter
Rate per 100,000 flying hours
189
168
147
126
105
84
63
42
21
0
52.6
56.0
1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
FY 77
FY 78
FY 79
FY 80

Appendix D
Maintenance-Related Errors by Type Aircraft

UH-1 Maintenance-Related Errors
1 October 1976-31 December 1980

Errors	Mishaps
1. Improper installation and routing of fluid/hydraulic lines (including O-rings and seals)	146
2. Improper wiring procedures that resulted in frayed/broken wires, shorts, and loose cannon plugs	99
3. Fuel control, overspeed governor, VIGV actuator, bleed band, linear actuator or droop cam improperly adjusted	86
4. Improper torque	82
5. Voltage regulator not adjusted properly or battery not properly maintained	65
6. Main rotor/tail rotor out of adjustment/balance	31
7. Maintenance-induced FOD to engines and other components	22
8. Incorrect part installed, part not installed or installed backwards	19
9. Fire detection system failed due to improper installation or wires shorting	15
10. Improper adjustment to flight idle stop/solenoid	13
11. Improper inspection procedures	12
12. Improper assembly of tail rotor control assembly	11
13. Engine dirty	11
14. Chip detector installed improperly or wire loose/broken	10
15. Doors, cowlings, access panels, etc., not secured	10
16. Improper aircraft washing/cleaning	10
17. Cyclic/collective controls not properly installed/adjusted	10
18. Insufficient lubrication	9
19. Fuel, oil, hydraulic cap not secured	9
20. Safety wire/cotter pin not installed	8
21. Improper engine cleaning procedure	7
22. Insufficient clearing instructions resulting in tree strikes, etc.	7
23. Improper assembly at depot or GS level maintenance	6
24. Fuel/oil drain/dump valve dirty causing loss of fluid	6

Errors	Mishaps
25. Unsecured/thrown objects into rotor system	6
26. Loose cannon plugs/FOD jamming flight controls	5
27. Contaminated fluids/filters clogged	5
28. Rotor tiedowns not removed before start	5
29. Tools left in aircraft caused damage	4
30. Cargo hook manual release out of adjustment	4
31. Particle separator, oil cooler or barrier filter dirty	4
32. Twenty-minute fuel light improperly adjusted	4
33. Protective covers not installed resulting in foreign object damage	4
34. Incorrectly installed bearings	3
35. Fluid lines locally manufactured incorrectly	3
36. Fuel quantity probe, fuel cell flapper valve, aux tank float switch improperly installed	3
37. Starter/beep switch contacts dirty	3
38. Weather boot not installed properly allowing water to contact electrical components	3
39. Improper engine assembly/maintenance	2
40. Multimeters, torque wrenches, etc., not calibrated	2
41. Engine/transmission oil pressure regulator not properly adjusted	2
42. Tracking flag/stick hit main/tail rotor	2
43. Cracked plexiglas due to improper installation	2
44. Inadvertent movement of flight controls while performing maintenance	2
45. Component removed but not written up	1
46. Improper installation of internal main transmission filter gasket	1
47. EGT thermocouple not installed properly	1
TOTAL	775

OH-58 Maintenance-Related Errors
1 October 1976-31 December 1980

Errors	Mishaps
1. Improper torque	64
2. Flight controls not properly installed, rigged or adjusted	39
3. Improper wiring procedures that resulted in frayed, broken wires, shorts, and loose cannon plugs	36
4. Improper fuel control, overspeed governor adjustments	27
5. Improper voltage regulator adjustments and battery servicing	26
6. Improper installation and routing of fluid, pneumatic lines	19
7. Maintenance-induced FOD to engines, rotors, and other components	18
8. Substandard or incorrect part installed	10
9. Improper inspection procedures	9
10. Improper installation of seals, gaskets, O-rings, and shims	8
11. Lubrication inadequate/excessive	8
12. Improper adjustment of linear actuator	6
13. Loose cannon plugs/coaxial cables jamming flight controls	6
14. Fairing, access panels, doors not properly secured/adjusted	4
15. Oil/hydraulic filler caps/plugs not properly installed	3
16. Improper engine cleaning procedures	3
17. TOT resistor coil out of adjustment or thermocouple improperly installed	3
18. Fuel control filter element installed backwards	2
19. Contaminated fluids	2
20. Improper assembly of components at depot/GS level	2
21. Chip detectors installed improperly	2
22. Improper assembly of tail rotor control system and tail rotor assembly	2
23. Engine/transmission oil pressure regulator valve improperly adjusted	2
24. Fuel control/governor linkage installed incorrectly	1
25. Electrical connectors improperly installed	1
26. Starter generator brushes improperly installed	1
27. Skid shoes not properly installed	1
28. Fuel system not purged after engine cleaning	1
29. Engine out warning system rpm improperly adjusted	1
TOTAL	307

AH-1/TH-1 Maintenance-Related Errors
1 October 1976-31 December 1980

Errors		Mishaps
1.	Improper installation and routing of fluid, pneumatic lines (including O-rings and seals)	87
2.	Maintenance-induced SCAS mishaps	27
3.	Improper wiring procedures that resulted in frayed, broken wires, shorts, and loose cannon plugs	24
4.	Improper fuel controls, overspeed governor, VIGV actuator, bleed band adjustments	18
5.	Improper assembly of tail rotor control system and tail rotor assembly	11
6.	Improper flight control installation rigging	9
7.	Improper voltage regulator adjustments and battery servicing	9
8.	Improper inspection procedures	8
9.	Maintenance-induced armament mishaps	7
10.	Improper torque	6
11.	Improperly installed cowling	6
12.	Improper assembly at depot factory	5
13.	Maintenance-induced FOD to engines and components	4
14.	Improper installation of internal main transmission filter gasket	4
15.	Improper engine cleaning procedures	3
16.	Tools left in the aircraft	3
17.	Improper washing procedures	3
18.	Loose cannon plugs and coaxial cables jamming flight controls	2
19.	Improper servicing	2
20.	Improper adjustment of linear actuator	1
21.	Insufficient lubrication	1
22.	Contaminated fluids	1
23.	Improperly manufactured fluid lines	1
24.	Improperly installed ECU ducting	1
25.	Improper adjustment of flight idle stop	1
26.	Improperly installed landing gear	1
27.	Improperly installed tach generator	1
28.	Oil pressure regulator not properly adjusted	1
29.	Inadequate supervision	1
	TOTAL	248

CH-47 Maintenance-Related Errors
1 October 1976-31 December 1980

Errors	Mishaps
1. Improper installation and routing of fluid, pneumatic lines (including O-rings and seals)	38
2. Improper torque	21
3. Improper hatch, door, and window maintenance and adjustment	15
4. Improper installation of engine fire detection sensing element	12
5. Insufficient lubrication	10
6. Rotor and transmission, blade stops, phasing, maintenance	10
7. Improper wiring procedures that resulted in frayed, broken wires, shorts, and loose cannon plugs	9
8. Improper fuel controls, overspeed governor, VIGV actuator, bleed band adjustments	5
9. Electrical cannon plugs improperly installed	4
10. Crew chief failed to provide sufficient instructions for clearing obstacles	3
11. Improper adjustment of linear actuator	3
12. Maintenance-induced FOD to engines and components	3
13. Insufficient cargo handling and tiedown, sling load procedures	3
14. Improper power plant maintenance	3
15. Engine oil filter improperly installed	3
16. Improper inspection procedures	2
17. Failure to secure oil filler cap	2
18. Cargo hook open light switch improperly adjusted	2
19. Engine fuel control improperly installed	2
20. Main fuel tank check valve insufficiently maintained	2
21. Crew chief inadvertently activated d.c. engine beep system, causing rotor overspeed	2
22. Improperly secured aux fuel tank fastener	1
23. Engine fuel filter improperly installed	1
24. Winch limit switch improperly adjusted	1
25. Transmission oil pressure transmitter cannon plug improperly installed	1
26. Flight boost manifold check valve improperly installed	1
27. Crew chief used improper procedure/fell out of aircraft	1
28. Crew chief provided incorrect in-flight emergency instructions	1
29. Contaminated fluids	1
30. Improperly manufactured fluid lines	1
31. Tools left in the aircraft	1
32. Improper assembly at depot factory	1
TOTAL	165

Fixed Wing Maintenance-Related Errors
1 October 1976-31 December 1980

Errors	Mishaps
1. Landing gear switches out of adjustment and improperly installed	36
2. Improper wiring procedures that resulted in frayed, broken wires, shorts, and loose cannon plugs	29
3. Landing gear malfunctions caused by maintenance actuators, retract components and doors, and leakage	29
4. Improper installation and routing of fluid, pneumatic lines (includes O-rings and seals)	27
5. Improper torque	23
6. Improper maintenance on engine, prop governor, and prop	17
7. Throttle control, prop control, mixture control, cables and linkage, adjustment, lubrication and installation	15
8. Loose fuel and oil caps and not properly sealed	13
9. Improper voltage regulator adjustments and battery service	8
10. Improper fuel control, fuel injector pump, and carburetor installation and adjustment induction system	8
11. Flight controls, maintenance, adjustment, and inspection	8
12. Cowling and inspection panels improperly secured	6
13. Improper cleaning procedures, airframe and components	5
14. Improper inspection procedures used IAW publications	4
15. Improper lubrication (lack of, wrong type components)	4
16. Ignition system malfunctions caused by maintenance	4
17. FOD in electrical system	4
18. Maintenance-induced FOD to engines and components	3
19. Doors, windows improperly installed or secured	2
20. Improper ground handling, towing, pushing and equipment, ground support	1
21. Filters not properly installed	1
TOTAL	247

Appendix E
Selected Mishap Briefs

Note: This mishap occurred after the study time frame but is included as an example.

During CH-47 slingload operations over mountainous terrain, all aircraft systems were responding normally as the crew made a shallow approach to the top of a ridge.

On releasing the load, the copilot, who was seated in the right seat and operating the controls, stabilized the aircraft at approximately 20 feet agl. During the hover, the crew felt and heard the rotor rpm increase to an indicated 242 rpm, then decrease below 214 rpm. The PIC attempted to regain control of the rotor rpm by means of the normal and emergency beep systems but was unsuccessful.

The copilot then made a descending turn to a relatively level area. As the aircraft touched down, a blade strike caused one blade to fail at the fourth pocket from the root, allowing it to fold upward. This induced severe vibration, causing the aircraft to bounce and slide toward the edge of the ridge. The aircraft's movement was finally halted when the right front and rear landing gear sank into soft earth and gravel. Total cost for repairs was estimated at more than $850,000.

Investigation revealed the No. 1 engine trim system malfunctioned because the pilot's No. 1 engine beep trim switch had been improperly installed. Further, the aircraft had not been placed on a red X status when the engine trim system had previously malfunctioned, during which time the switch was replaced. As a result, the maintenance work was not inspected by a TI nor was a maintenance operational check performed as required by TM 55-1520-227-23-2. ■

With one passenger on board, the pilot of an OH-58 attempted a left hovering turn when he noted that the left control pedal bottomed out prematurely. The aircraft then began spinning uncontrollably to the right. The pilot increased collective and attempted to fly out of the spin. This spin was unsuccessful and when the low rpm audio sounded, the pilot decreased collective to set the spinning aircraft on the ground.

During the landing attempt, the main rotor struck the ground and the aircraft rolled on its right side. Both occupants exited through the left crew door without injury. The aircraft was destroyed.

Investigation revealed that maintenance personnel used improper procedures during the installation of the tail rotor pitch change control tube, P/N 206-011-724-1. This resulted in one roller becoming dislodged from the control housing roller bearing, P/N 206-011-731-1. During flight, the dislodged roller became trapped between the pitch key, P/N 206-011-704-1, and the end of the key slot, restricting left pedal movement of the pitch control tube by approximately 7/16 inch. This resulted in insufficient antitorque control. ■

Following takeoff, the pilot of a U-8F placed the gear selector handle in the up position, but the gear did not retract. Because of heavy air traffic in the vicinity of the airfield, the crew became engrossed in making radio calls for an IFR clearance and failed to notice the gear remained in the extended position. Consequently, climb to cruise altitude was continued for several minutes with the gear extended before the crew noticed the red light in the gear handle. They then attempted to recycle the gear without success.

Although the main gear cannot be seen from the cockpit, the crew was able to confirm the nose gear was in the extended position by means of mirrors on the engine nacelles. While attempting to decide on the best course of action, the crew noticed the No.1 engine cylinder head temperature rising to the red line. At this time, the engine began to detonate and surge. Interpreting this as impending engine failure, the crew made no attempt to reduce power and increase airspeed for cooling. Instead, they promptly shut down the No. 1 engine and feathered the propeller.

On their return to the airfield, the pilots cancelled their IFR clearance, informed the tower of their problem, and requested a visual check of the gear. After being told the gear appeared to be down, the pilots assumed the main gear indicators, which showed "unsafe," were in error. Therefore, they made no attempt to insure that both main gears were fully extended and locked by use of the manual crank before attempting to land the aircraft.

Following rollout, the pilots decided to turn off the active runway before shutting down the aircraft and calling on maintenance personnel for assistance. As they began their turn, the right main gear started to collapse, then the left. The aircraft settled on its belly and skidded approximately 3 feet before stopping. The nose gear remained down and locked. Damage to the aircraft was estimated at approximately $24,000.

Investigation revealed that the mechanic who performed the daily inspection had noted the nose gear downlocks needed adjustment. So he removed the forward end of the drag brace and filed the downlock hook to obtain the necessary clearance. While performing the needed maintenance, he was interrupted twice—first, to refuel the aircraft, and second, to assist another mechanic on a different aircraft. Following the first interruption, the mechanic reconnected the drag brace, installed the attaching bolt, and finished the job by safetying the nut on the connecting bolt with a new cotter pin. At this time he was called to assist another mechanic and did not return to the U-8. As a result, no entry was made in the aircraft log and the nose gear was not inspected.

Unfortunately, when he reinstalled the forward drag brace bolt, he inadvertently failed to insert it through the hole in the drag brace. Consequently, during the

retraction attempt following takeoff, the drag brace could not unlatch the downlocks so that the nose gear could retract. As a result, binding of the gear drive system occurred immediately after the main gear unlocked and started to retract. This binding condition caused the drive motor clutch to slip until the landing gear motor overheated and tripped the system circuit breaker. This completely disabled the system with the main gear in an unsafe condition.

The additional load imposed on the engines by the extended gear while the aircraft remained in a climbing attitude for several minutes caused the left engine to overheat, detonate, and surge.

Although the pilots failed to follow the emergency procedures checklist which would have allowed them to manually extend and lock the main gear, preventing the accident, failure of the mechanic to correctly install the nose gear forward drag brace bolt precipitated the events that led to the accident. These events could still have been prevented had the mechanic been allowed to complete his work without the interruptions that occurred. These interruptions prevented him from making any entry in the aircraft log, and allowed the aircraft to be flown without an inspector's approval. ■

The pilot of a UH-60 was attempting a roll-on landing when the aircraft began to yaw to the left. The IP took the controls, corrected for the left yaw, brought the aircraft to a hover, and applied right pedal to align the aircraft with the lane. The aircraft immediately began to yaw to the right. The IP applied full left pedal but the aircraft continued to spin to the right at an increased rate of acceleration. Unable to check the spin, the IP leveled the aircraft, reduced collective, and set the aircraft on the ground. On landing, the tail wheel broke and separated from the aircraft, causing damage to the fairings and left stabilator. Cost for repairs was estimated to be approximately $25,000.

A check of maintenance records showed the oil cooler fan had been replaced several months before the mishap, during which period the aircraft had accumulated 183 hours of flight. Investigation revealed that the oil cooler fan exit flange failed in flight, disconnecting the tail rotor drive shaft. This resulted in loss of directional control. Further investigation determined the oil cooler fan exit flange failed because of excessive shaft runout—the result of misalignment.

Maintenance personnel did not check shaft runout following the oil cooler fan installation as required because of inadequately written maintenance procedures. TM 55-1520-237-23-7, Task 46, was found to be deficient in format and lacking in detail. In addition, a required special tool was omitted from the tool list. Collectively, these deficiencies made it appear that Task 46 was completed upon the installation of the oil cooler.

Following the investigation of this mishap, runout checks were performed on seven other UH-60 aircraft on which oil cooler fans had been replaced. The shafts on five were found to be out of alignment. ■

Two pilots were aboard a UH-1 which was seen to enter an uncontrollable descending right turn and crash. Both crewmembers sustained fatal injuries, and the aircraft was destroyed.

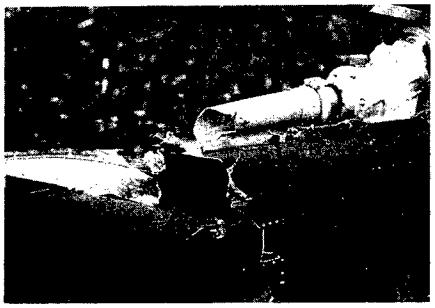
Investigation revealed a trunnion had separated from the outer swashplate ring, causing loss of control of the aircraft. It was determined that the assembly had not been properly inspected and maintained.

A check of the trunnion bores in the swashplate outer ring showed them to be egg shaped, and the inside diameter of each was excessive. In addition, the possibility exists that insufficient torque had been applied to the clamping bolts of the damaged swashplate outer ring trunnion bore.

Failure of maintenance personnel to use the special tool required when performing maintenance on trunnion assemblies and failure to follow correct TM procedures was evidenced during a one-time inspection of UH-1 aircraft following this mishap.

A common discrepancy noted was the use of screwdrivers or other unauthorized tools to spread trunnion housing ears during removal and installation of trunnions. In fact, a section of one trunnion housing broke when a mechanic pried the ears apart with a screwdriver. Ironically, this occurred while he was performing a one-time inspection of trunnion assemblies.

Other discrepancies included failure to properly align trunnion slots with bolt holes and forcing retaining bolts in place by pounding them with a hammer or twisting them with a wrench when bolt holes and trunnion slots were not properly aligned. ■



While inbound at about 1,125 feet agl at an airspeed of 90 knots, the crew of an AH-1 heard a loud noise coming from the engine and noted the engine tachometer and N_1 decreasing to zero. The pilot immediately reduced collective pitch and entered autorotation. During the forced landing attempt to an open field, the skid heels dug into the soft soil, causing the aircraft to rock forward. As the aircraft rocked back to a level attitude, the main rotor blades flexed into the tail boom, separating the No. 4 drive shaft section from the aircraft and partially severing the tail boom. Both crewmembers exited the aircraft without injuries. Damage costs were estimated at approximately $199,000.

Investigation revealed that sudden and catastrophic failure of the engine had occurred as a result of improper maintenance during replacement of the fuel control unit. When mechanics replaced the unit, they installed a temperature sensing assembly that was not calibrated to the fuel control. This mismatching of assemblies was contrary to the instructions provided in change 15, TM 55-2840-229-24, par 5-70. Failure to comply with stipulated TM procedures resulted in unmanaged fuel flow to the engine, high temperature, and catastrophic failure of the turbine section. ■

Appendix F
DA Form 285 Ground Mishaps

Number of mishaps: 214
Total Cost: $1,067,910
Injuries: 125
Fatalities: 0

	Occurrences
1. Injuries/damage sustained during ground handling of aircraft or equipment.	36
2. Falls from aircraft/work area due to oil spillage, water, snow, or inattention.	34
3. Fuel, solvent, cleaning compound, inhibosol, aerosol, proseal got into eyes.	15
4. Injuries/damage sustained using tools/equipment due to inattention or improper procedure.	14
5. Rotor blade damaged when it fell off the stand or platform during maintenance.	13
6. Injuries/damage sustained during installation/maintenance of rotor head and swashplate.	13
7. Improper jacking procedures or defective jacks were being used.	11
8. Use of improper/defective tool resulted in damage or injury.	9
9. Damage to cowlings, doors, etc., and injuries to personnel due to high winds or rotorwash.	8
10. Injuries/damage sustained during hoist operations due to inadequate attention/ improper procedures.	7
11. Defective lifting devices used, e.g., portable crane, overhead hoist, engine sling, resulting in damage/injuries.	6
12. Personnel overexerted themselves by attempting to lift too much weight or used incorrect lifting procedure.	5
13. Metal shavings/safety wire got into eyes during drilling, grinding, or safetying.	4
14. Stepped through plexiglas on top of aircraft.	3
15. Overpressurized fire extinguisher, hydraulic dispenser, or other container, causing rupture/explosion.	3
16. Battery not disconnected, circuit breaker not pulled, safeties not installed when jettison cartridge installed - accidental jettison of canopy.	3
17. As crankshaft was rotated, engine fired, and propeller struck mechanic.	2
18. Head injuries due to inattention.	2
19. KY 28 and roll of safety wire fell through UH-1 chin bubble.	2
20. Unserviceable maintenance platform tipped over, causing injury.	2
21. Tracking flag damaged main rotor blades.	1
22. Aircraft tire being removed while still under pressure injured mechanic.	1
23. Hangar door lowered on aircraft.	1

	Occurrences
24. Towing vehicle left unattended rolled into aircraft .	1
25. OV-1 drop tank released without draining fuel resulted in maintenance personnel dropping tank.	1
26. Mechanic attempted to chock CH-47 tire before aircraft had completely stopped - finger caught between wheel and chock.	1
27. Insufficient clearance to extend C-12 flaps - flaps hit nose of nearby T-42.	1
28. Starter shield was not used during engine flush, resulting in starter fire.	1
29. Jacket sleeve caught in gun turret mechanism. Arm injured when turret went to stow position.	1
30. CH-47 ramp lowered due to lack of hydraulic pressure. The ramp shorted out an electrical light set.	1
31. While cleaning a work table, a small metal shaving stuck to mechanic's hand. Mechanic rubbed his eye, transferring the shaving to his eye.	1
32. With 42-degree gearbox removed, UH-1 tail rotor started to freewheel due to wind. TI attempted to stop the rotor with his foot, resulting in injury to his foot.	1
33. Attempting to open AH-1G canopy mechanically, inadvertently jettisoned the canopy.	1
34. Bungie cord used to secure troop seats broke and cord end hit mechanic in the eye.	1
35. Fuel handler fell from tanker when he became nauseous due to JP-4 fumes.	1
36. Mechanic backed into floor fan and had his arm lacerated.	1
37. Test equipment located in the exhaust stack of an OV-1D was not detected by EM prior to ground runup.	1
38. Mechanic using aerosol can of zinc chromate primer to spot paint inside of radio compartment became ill due to lack of respiratory protection.	1
39. Mechanic injured his hand when he placed it in the blower fan.	1
40. Mechanic threw screwdriver to NCO and screwdriver hit NCO in the eye.	1
41. Mechanic raised collective while TI had hands in the vicinity of the collective lever bearings, resulting in injury to the TI's hand.	1
42. Mechanic experienced cold weather injuries because he did not take the necessary precautions.	1
TOTAL	214

NOTE: Mishaps involved maintenance personnel performing maintenance-related tasks.